Catherine

state of utah

DIVISION OF WILDLIFE RESOURCES
DOUGLAS F. DAY
Director
EQUAL OPPORTUNITY EMPLOYER
1596 West North Temple/Salt Lake City, Utah 84116/801-533-9333

Reply To
NORTHEASTERN REGIONAL OFFICE
671 W. 100 N., Vernal, Utah 84078 / (801) 789-3103

May 12, 1983

William L. Sharrer
Environmental Engineer
Geokinetics, Inc.
P.O. Box 1168
Vernal, Utah 84078

Dear Bill:

I have reviewed the Intermountain Forest and Range Experiment Station's study proposal for revegetation of in situ retorts, which you provided us for informational purposes, and have the following comments and suggestions for your consideration.

The proposed seed mixtures are weighted heavily toward grasses and contain only one forb species. Since this location is a prime wintering area, and deer are almost exclusively dependent on browse species at that time of year, the mix will be of virtually no benefit to deer.

Objective 5 of the proposal is to determine the success of shrub establishment when directly seeded with perennial grasses. Several investigators (Holmgren, 1956; Institute for Land Rehabilitation, 1979; Norton, 1982) have previously demonstrated that establishment, survival and vigor are drastically reduced in the presence of herbaceous competition. It seems, therefore, that this facet of the study plan is unnecessary.

Some shrub species, such as sagebrush, are adapted to low nitrogen soils and are not stimulated by increased nitrogen availability. Some grasses, on the otherhand, are greatly stimulated by added nitrogen. Shrubs are slow growing while grasses are precocious and aggressively outcompete shrubs for available moisture and nutrients. Fertilizing of the plots is likely to be of benefit only to the grasses which would further reduce shrub establishment and survival.

I recognize the need for the immediate establishment of a ground cover to decrease soil erosion, but we also see the necessity for the expeditious re-establishment of shrubs to this important deer winter range. Both these objectives could be met with some modification to the original study proposal.

The development of shrubs from seed is a painfully slow process with a high mortality rate. The use of container grown stock would insure greater survival success. Shrub plots should be established separate from the grass and forb plots and, if possible, maintained weed free for the first year of growth. This would allow shrub development to proceed without unnecessary stress from herbaceous competition.

A mosaic of grass-forb plots and shrub plots would allow a quick ground cover to develop in some areas and uninhibited shrub growth to occur in others. This diversification of growth forms would benefit several wildlife species while still accomplishing the objectives of stabilizing disturbed sites.

Sincerely,

Michael A. Schwinn

Michael A. Schwinn
Regional Energy Biologist

cc: Robert B. Ferguson

EFFECT OF SEASON OF SEEDING AND MULCHING TREATMENT ON REVEGETATION SUCCESS ON IN SITU OIL SHALE RETORTS

STUDY PLAN

By

ROBERT B. FERGUSON

Intermountain Forest and Range Experiment Station

Research Work Unit 1603

Logan, Utah

In Cooperation With:

Geokinetics, Incorporated

Concord, California

Geokinetics, Incorporated of Concord, California, is presently extracting oil from oil shale located in the southern portion of Utah's Uinta Basin by an in situ retorting process. The method used involves fragmenting the oil shale by setting off precisely placed explosive charges. Following fragmentation, holes are drilled into the shale layer and the shale is ignited. Air is forced into the holes to supply oxygen to sustain combustion. As the combustion front progresses horizontally, the kerogen in the shale is pyrolized and condensed. The synthetic crude then drains to the retort bottom and is recovered through pump wells.

The first of these in situ retorts were small (400 sq. ft. to less than 1/3-acre). However, recently developed retorts have approached two acres in size. The oil shale rock has been covered by only 2 to 60 feet of overburden. As a result of the fragmentation of the shale by explosives, the overlying material is often lifted up to form a mound over the fractured zone of shale. Such mounds may be as much as 6 feet (usually less) higher than the original land surface.

The land surface immediately above the retort is usually denuded of vegetation in the process of drilling and pumping. It is often necessary to remove pinyon or juniper trees to facilitate the procedure. The area adjacent to the retorts is also disturbed by the movement of equipment and vehicles.

Efforts have been made since about 1979 to develop successful methods of re-establishing a vegetative cover on retort areas from which the extraction of shale oil has been completed. These efforts have met with limited success, especially on the "raised" portion of the retorts where soil material is often shallow. Some areas around the edges of the raised retorts have supported good stands of grass. Thus the primary obstacle to successful establishment of adequate vegetation appears to be a lack of soil depth. Associated with

the factor of soil depth is the necessity to prepare the soil surface in a manner that will retain precipitation or applied supplemental water on the area and hold surface runoff to a minimum.

There is a need to include adapted legume and shrub species in revegetation planning. Several adaptability trials made on smaller retort areas of the Geokinetics site have revealed a number of shrubby and herbaceous species that can be used in reclamation. However, most of the species tested to date have been plants that are not native to this part of Utah, or were native species the seed of which was collected in other parts of Utah or the Intermountain West. Local sources of native shrub species should be tested to determine their competitive capacity when used in a seed mixture.

This study is designed to yield information on alternative cultural methods and suitable herbaceous and shrubby species for establishing a level of vegetative cover adequate to meet government reclamation requirements. Specific objectives are: (1) to determine the relative success of direct seeding in conjunction with three mulching treatments (straw, wood fiber, or no mulch), (2) to evaluate the vegetative stand obtained when only herbaceous species are used or when both herbaceous and shrubby species are used. (3) to obtain preliminary information on the value of supplemental water, applied by irrigation during the growing season, on successful vegetation establishment, (4) to assess the effect of season of direct seeding (spring vs. autumn) on vegetation establishment, and (5) to determine the success of establishment of several native shrub species when direct seeded in association with perennial grasses.

STUDY AREA

Location of the study area is on lands owned by the State of Utah, and leased by Geokinetics, Incorporated, in Section 2, Township 14 South, Range 22 East, Uintah County.

Elevation at the site is approximately 6,700 feet (2 042 m). Average Annual precipitation is about 13 inches. Native vegetation of the area is dominated by the pinyon-juniper type, with locally interspersed areas of sagebrush-grass and sagebrush-saltbush types. Soils are well drained, and derived primarily from shale and sandstone parent material.

METHODS

A 1.25- acre retort (Geokinetics No. 24) was selected by Geokinetics for use in this study.

Shale oil extraction from the retort began in December, 1980 and was completed in July, 1981. The top of the burned oil shale layer was approximately 45 feet below the original ground surface. Retorting was begun under the southeast end of the retort and proceeded toward the northwest end.

Upon completion of shale oil extraction, the retort surface was covered with approximately four inches of the topsoil material that was originally removed in preparation for "burning" the retort, and then reshaped to minimize the slopes around the retort perimeter (Appendix Figure 1).

Soil samples were taken from the top 12 inches of the soil material in November, 1982, and exhibited the following characteristics:

Soil reaction (pH): 8.0-8.4 ($\bar{x}$ = 8.1)

electrical conductivity (ECe): 2.6-6.8 ($\bar{x}$ = 4.6)

phosphorous (ppm): 1.6-7.8 ($\bar{x}$ = 3.7)

potassium (ppm): 284-400 ($\bar{x}$ = 348)

sodium (meq /l); 8.3-42.2 ($\bar{x}$ = 24.6)

estimated SAR: 2.8-14 ($\bar{x}$ = 7.4)

Treatments

The following five treatments will be applied on the retort area; half of the area will be treated in early April 1983, and the remaining half will be treated in October or November, 1983. (The plot design is shown in Appendix Figure 1):

(A) seeded with a grass-forb mixture, and muched with straw

(B) seeded with a grass-forb mixture, and mulched with wood fiber

(C) seeded with a grass-forb-shrub mixture and mulched with straw

(D) seeded with a grass-forb-shrub mixture, and mulched with wood fiber.

(E) seeded with a grass-forb-shrub mixture, but not mulched

The seed mixture will be as follows, contingent on availability of seed:

For treatments A and B:	lbs./acre PLS
Bouteloua gracilis; "Lovington"	1
Sporobolus airoides	0.5
Oryzopsis hymenoides; "Nezpar"	3
Agropyron elongatum; "Alkar"	6
Agropyron inerme; "Whitmar"	4
Agropyron smithii; "Rosanna"	4
Ag. spicatum X Ag. repens; ARS hybrid	3
Elymus junceus	4
Hedysarum boreale	2
	27.5

For treatments C, D, and E:	lbs./acre PLS
Bouteloua gracilis; "Lovington"	1
Sporobolus airoides	0.5
Oryzopsis hymenoides; "Nezpar"	2
Agropyron elongatum; "Alkar"	4
Agropyron inerme; "Whitmar"	2
Agropyron smithii; "Rosanna"	2
Ag. spicatum X Ag. repens; ARS hybrid	1.5
Elymus junceus	2
Atriplex canescens	4.3
Atriplex confertifolia	3.7
Artemisia tridentata	0.3
Ceratoides lanata	2.4
Chrysothamnus nauseosus	0.1
Hedysarum boreale	2
	27.8

Site Preparation, Seeding, and Mulching

Prior to seeding, inorganic fertilizer will be broadcast on the entire study area at the rate of 60 lbs/acre of nitrogen and 51 lbs/acre of phosphorus. Fertilizer will be incorporated into the top 12 to 14 inches of soil by ripping and harrowing. In addition, gypsum will be applied, with the fertilizer, at a rate of one ton per acre.

Seed will be sown with a Brillion seeder-cultipacker, drawn by a small caterpillar tractor. Sufficient seed will be placed in the seed hopper to permit the seeding of treatments A and B first (no shrub seed included). Once

treatments A and B are completed, the seed hopper will be loaded with sufficient grass and forb seed to seed treatments C, D, and E. However, shrub seed will be mixed together and divided into small packets, with one packet of seed added to the seed hopper as each 5-ft by 175-ft strip is sown.

Mulching material will be applied immediately after seeding. Straw will be spread at 2,400 lbs/acre and tacked down with a straw crimper. Wood fiber will be blown on at a rate of one ton per acre.

Provision for Supplemental Water

One-half of both the spring and autumn seeded areas will be sprinkler irrigated. Irrigation will begin no later than April 15, and will be applied at a rate of one inch of water on the initial date of irrigation and 0.5-inches of water at weekly intervals thereafter, through September 2. This is equivelent to 11 inches of water (298,700 gallons/acre) for the 21-week period.

Soil water potential will be monitored twice monthly, beginning six days after the date of initial irrigation, through the use of thermocouple psychrometers. Preferrably, readings will be made on the day prior to each irrigation, or immediately before turning on the irrigation system. Psychrometers will be placed in the soil at four locations on the irrigated half of the seeded area and at four locations on the non-irrigated area. At two of the four locations, psychrometers will be placed at depths of four, eight, and 12 inches, while at the other two locations an additional psychrometer will be placed at a depth of 24 inches. Soil temperature can be monitored with the same thermocouple psychrometers.

Experimental Design

The study will be set up as a stratified randomized, split plot design, with five blocks. Each treatment will be represented in each block by a 5-ft wide by 175-ft long strip (Appendix Figurel).

Data will be taken on percent frequency in August of each growing season, using a nested plot plot method, as described in section 4.63 of FSH 2209.21 R-4 (Range Analysis Handbook). In each 5-ft by 87.5-ft strip (representing a single treatment in each "block"), a 10-sq. ft sampling frame will be placed down five times. The locations will be chosen by drawing random numbers from 1 to 88, which in turn represent one-foot segments along a tape stretched along one side of the strip to be sampled. The 10-sq. ft frame is divided into 10 sq.-ft. subplots, one of which is further divided into 9 sq.-dm subplots. Each time the frame is placed down, the presence of each specific class or species being sampled will be recorded in four sizes of plot, i.e. 10-sq. ft., 5-sq.ft., one-sq.ft., and one-sq.dm.

In August 1983 "grasses" will not be sampled by individual species because of the tediousness of distinguishing species of very young plants. Similarly, in August 1984 grasses from the seeding made in the autumn of 1983 will be tallied as a class. Forbs and shrubs will be recorded by individual species on each sampling date. Grass species should be recognizable by the second growing season.

Beginning with the 1985 sampling, data will be taken on yield, by species, utilizing the same randomly located 10-sq.ft. plots from which frequency data are obtained. It may be desirable to sample in July instead of August, beginning in 1985. The weight-estimate method will be used for sampling yields.

Data on percent frequency and yield will be subjected to analysis of variance, as outlined below.

	d.f.
Blocks (5)	4
Treatments (5)	4
Error	16
	24

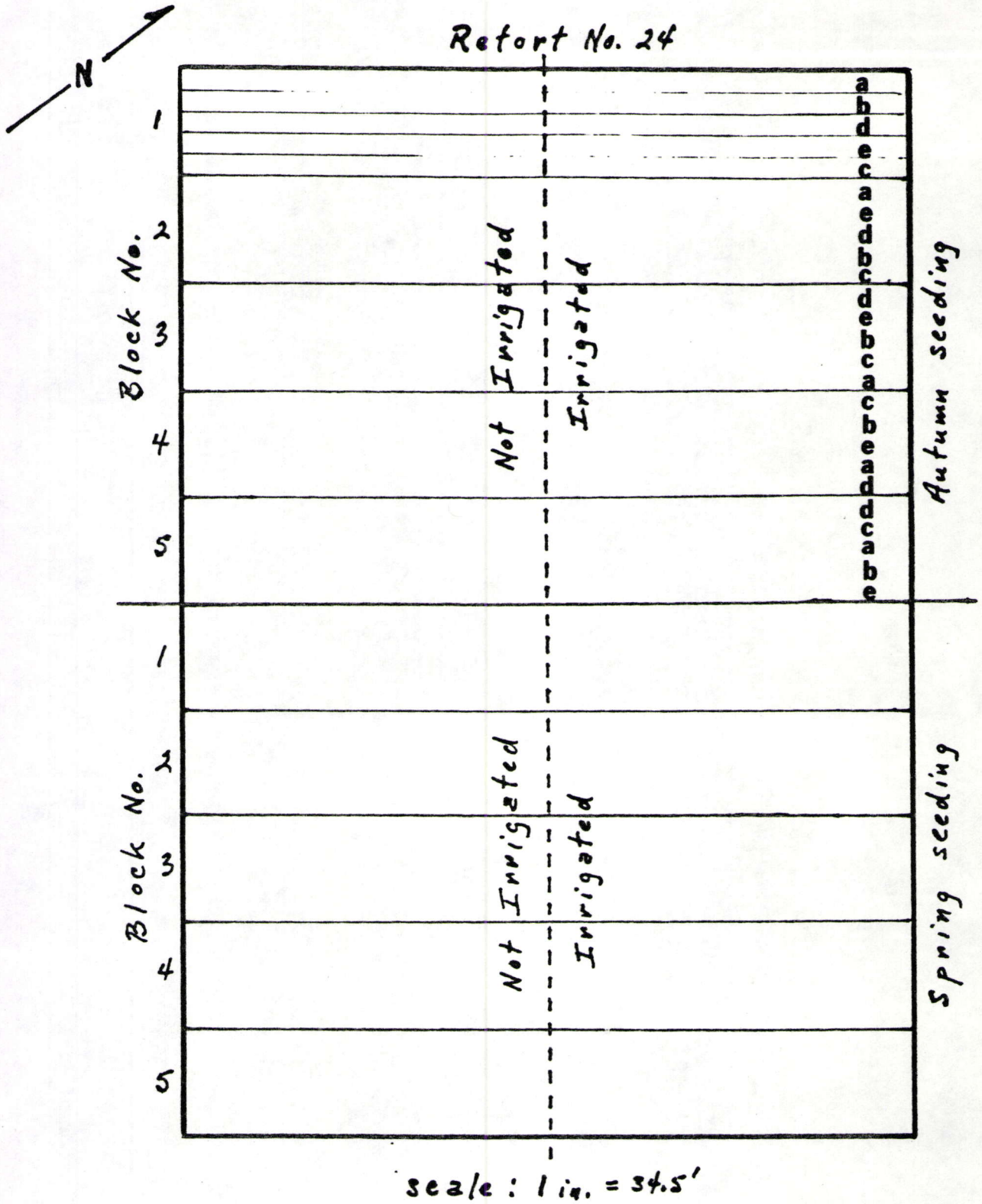
If analyses of variance tests indicate significant differences between treatments, data will be examined and a decision made on appropriate transformation and multiple comparison methods.

Study Establishment and Data Collection

Personnel of the Intermountain Forest and Range Experiment Station will prepare the retort surface and make the seedings, both in the spring and autumn of 1983. Station personnel will also install the irrigation system, with the assistance of Geokinetics personnel, and will install thermocouple psychrometers as outlined in the study plan.

Data on vegetation parameters will be obtained by Intermountain Station personnel. Data on soil water potential will normally be collected by Geokinetics personnel, as it would be too expensive for Station personnel to travel to the study site from Logan or Provo on a weekly or bi-weekly basis.

Geokinetics, Inc. will apply supplemental water as scheduled, or deemed to be needed, depending on natural precipitation received.



Appendix Figure 1. Field plot design for Retort No. 24, showing season of seeding, treatment sequence within each block, and irrigated vs. not irrigated portions.

COOPERATIVE AGREEMENT

between

Geokinetics, Inc.

and

Intermountain Forest and Range Experiment Station,
USDA - Forest Service

THIS AGREEMENT, made and entered into by and between Geokinetics, Inc., hereinafter referred to as the Cooperator, and the Intermountain Forest and Range Experiment Station, USDA-Forest Service, hereinafter referred to as the Experiment Station under provisions of the Act of June 30, 1978 (16 USC 1641-1646),

WITNESSETH:

WHEREAS, the Experiment Station is authorized to conduct research concerned with soils, water, vegetation, and other natural resources of forest and rangeland, and to accept contributions in the furtherance of such work; and

WHEREAS, the Cooperator desires to contribute to such work,

NOW, THEREFORE, in consideration of the above premises, the parties hereto agree as follows:

A. The Cooperator agrees to:

1. Contribute $4133.00 (forty one hundred and thirty three dollars) which may be expended by the Experiment Station upon its acceptance. Additional contributions may be made as specified below. All contributions will be available to pay costs of any research work performed by the Experiment Station including indirect costs.

   The total money contribution under this agreement will be $11,146.00 (eleven thousand one hundred and forty six dollars). Deposits after the first one are to be made as follows: $5,440.00 (five thousand four hundred and forty dollars), deposited on October 1, 1983; and $1,573.00 (one thousand five hundred and seventy three dollars) deposited on October 1, 1984.

   All remittances shall be made payable to the Forest Service, USDA, and sent to the Collection Office, USDA, Forest Service, 507 25th Street, Ogden, Utah 84401.

   In the event the research is not performed, the Experiment Station agrees to refund the deposit.

2. Permit the installation of revegetation study plots as well as instrumentation thereon.

3. Provide a mutually acceptable study site.

4. Permit access to the study site during the terms of this agreement.

5. Protect research sites, equipment and facilities on the study area from any acts of the Cooperator, their employees, agents, or contractors that might cause damage to said area, equipment, or facilities or interfere with the research work to be accomplished hereunder. However, in no case will the cooperator, their employees, agents, or contractors be held liable for said damages.

6. Purchase all supplies for use on the research site. These include seed, fertilizer, and mulch as will be specified in the detailed study plan. Purchase, install and operate irrigation equipment as detailed in the study plan.

7. Transport revegetation equipment from Logan, Utah to the site and return for the spring and fall seedings of 1983. Equipment includes tractor (14,000 pounds), harrow, straw crimper, and seeder.

B. The Experiment Station agrees to:

1. Provide the leadership and supervision essential to the satisfactory conduct of this research.

2. Conduct the research work briefly described below:

a) Evaluate revegetation trials on retort #24, approximately one acre in size.
b) Evaluate spring versus fall seeding dates. For spring seeding, evaluate irrigation versus no irrigation.
c) Treatments:

1 site preparation treatment
1 fertilizer treatment (based on soils analysis)
3 mulch treatments; none, straw, wood fiber
2 grass mixtures; grass only, grass-shrub-forb mix (species to be selected later)
2 seeding dates; April, 1983, and November, 1983. About half of the April seeding to be irrigated on an as-needed basis.

G + grass seed, S = shrub seed, F + forb seed

Treatment codes:
#1, G-S-F with straw
#2, G-S-F with wood fiber
#3, G-S-F with non, surface gouging may be used if equipment is available
#4, G with straw
#5, G with wood fiber

3. Prepare a mutually acceptable, detailed study plan by April 1, 1983. The research work is to be performed by the Experiment Station on a schedule mutually agreed upon between the parties.

4. Be responsible for the collection, compilation, and analyses of all field data.

5. Furnish three (3) copies of a final report at the conclusion of the work.

6. When mutually agreed upon, to work with the Cooperator in application of technology developed under this agreement.

C. It is mutually agreed that:

1. No contributions herein provided for shall entitle the cooperator to any share or interest in any equipment or materials purchased by or furnished to the Experiment Station for the conduct of this research. All such equipment and materials shall be and remain the property of the United States.

2. That no Member of, or Delegate to, Congress, or Resident Commissioner, shall be admitted to any share or part of this agreement or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

3. That nothing in this agreement shall be construed as obligating the Experiment Station to expend, or as involving the United States in any contract or other obligation for payment of money in excess of appropriations authorized by law, and administratively made available for this work.

4. That the United States shall not be liable to the Cooperator for any damage incident to technical advice furnished under this agreement.

5. Employees of the Cooperator working under this agreement are not considered agents of the United States. Because of the lack of agency, the United States will not be responsible for damage incident to performance of work under this agreement.

6. That neither party will publish any results without consulting the other. This is not to be construed as applying to popular publication of previously published technical matter. Publication may be joint or independent as may be agreed upon, always giving due credit to the cooperative parties and recognizing individuals doing the work. In the case of failure to agree as to manner of publication or interpretation of results, either party may publish data after due notice and submission of the proposed manuscripts to the other. In such instances, the party publishing the data will give due credit to the Cooperation, but assumes full responsibility for any statement on which there is a difference of opinion. Reports on this work published by the Experiment station for public use may be distributed by the

Cooperator, through advertising or other media, will not be made in any way that implies the approval or endorsement by the Experiment Station of a particular manufacturers proprietary product or process, or which broadens or distorts the factual findings of this research.

7. This agreement may be terminated by either party by giving 30 days' notice in writing to the other party, provided that any funds on deposit will be available for expenses incident to closing out of this work.

8. This agreement will remain in effect until September 30, 1985, unless sooner terminated.

9. Geokinetics shall have a right to limit the use of the name Geokinetics.

D. Financial Plan:

1. Cooperator share of cost:

Upon agreement execution	4,133.00[1]
October 1, 1983	5,440.00[1]
October 1, 1984	1,573.00
	11,146.00

Experiment Station share of cost:

FY 1983	6,987.00
FY 1984	6,981.00
FY 1985	5,127.00
	19,095.00
GRAND TOTAL	30,241.00

2. Approximate cost breakdown

Cooperator contribution:

Salaries (technician)	1,800.00
Per diem	3,600.00
Vehicles	1,960.00
Soil and Vegetation Analysis	600.00
Computer time	400.00
Indirect costs	2,786.00
	11,146.00

Experiment Station contribution:

Salaries (professional)	13,316.00
Salaries (technician)	960.00
Indirect cost	4,774.00
	19,095.00

[1]Footnote: Cooperator may choose not to haul equipment as agreed in paragraph A4, and contribute an additional $500.00 to the Experiment Station for actual and indirect costs.

IN WITNESS WHEREOF, the parties hereto have executed this agreement as of the last date written below.

GEOKINETICS, INC. _____ Date

Roger R Bay 2/10/83

ROGER R. BAY, Station Director Date
Intermountain Forest & Range Experiment Station